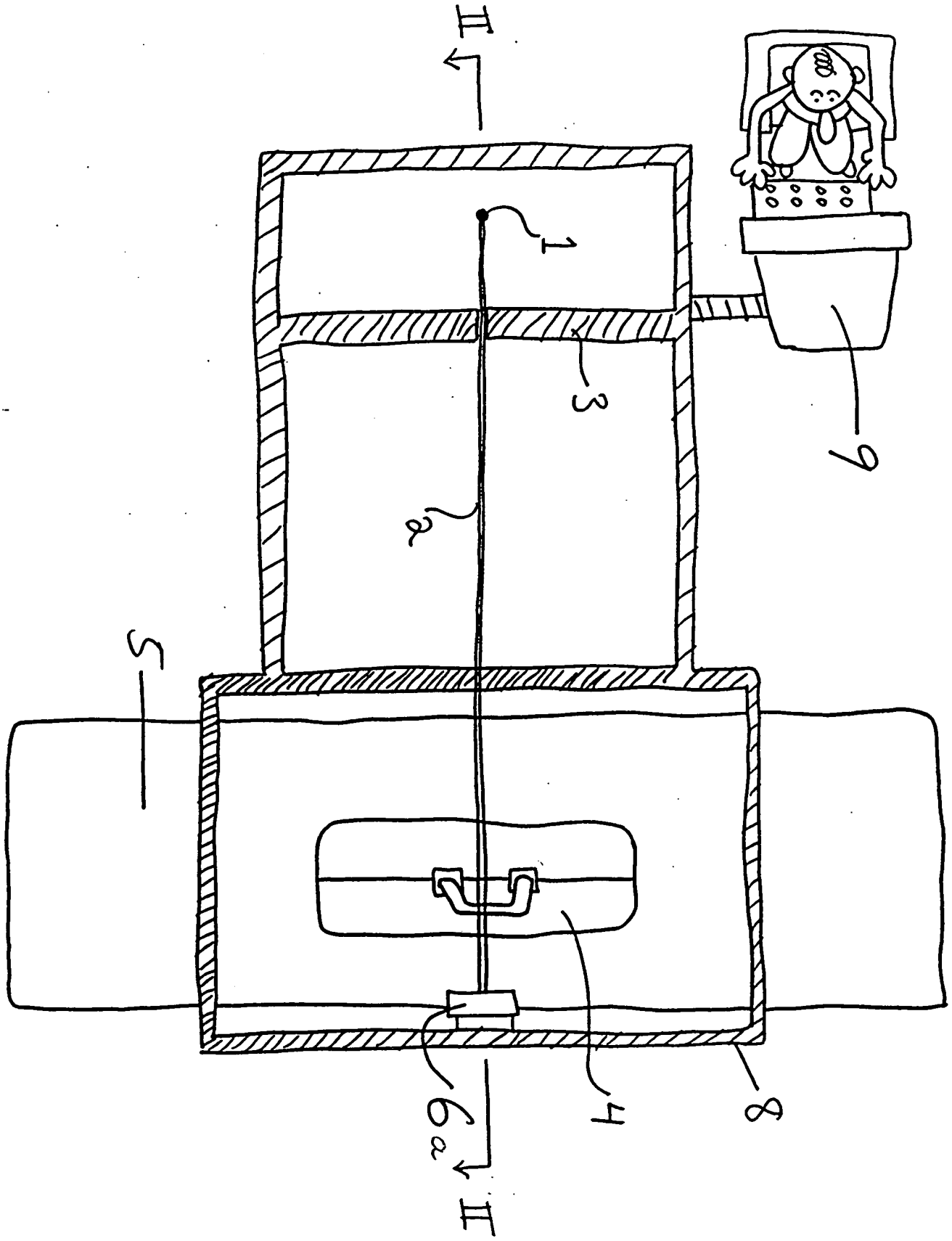


FIGURE 1

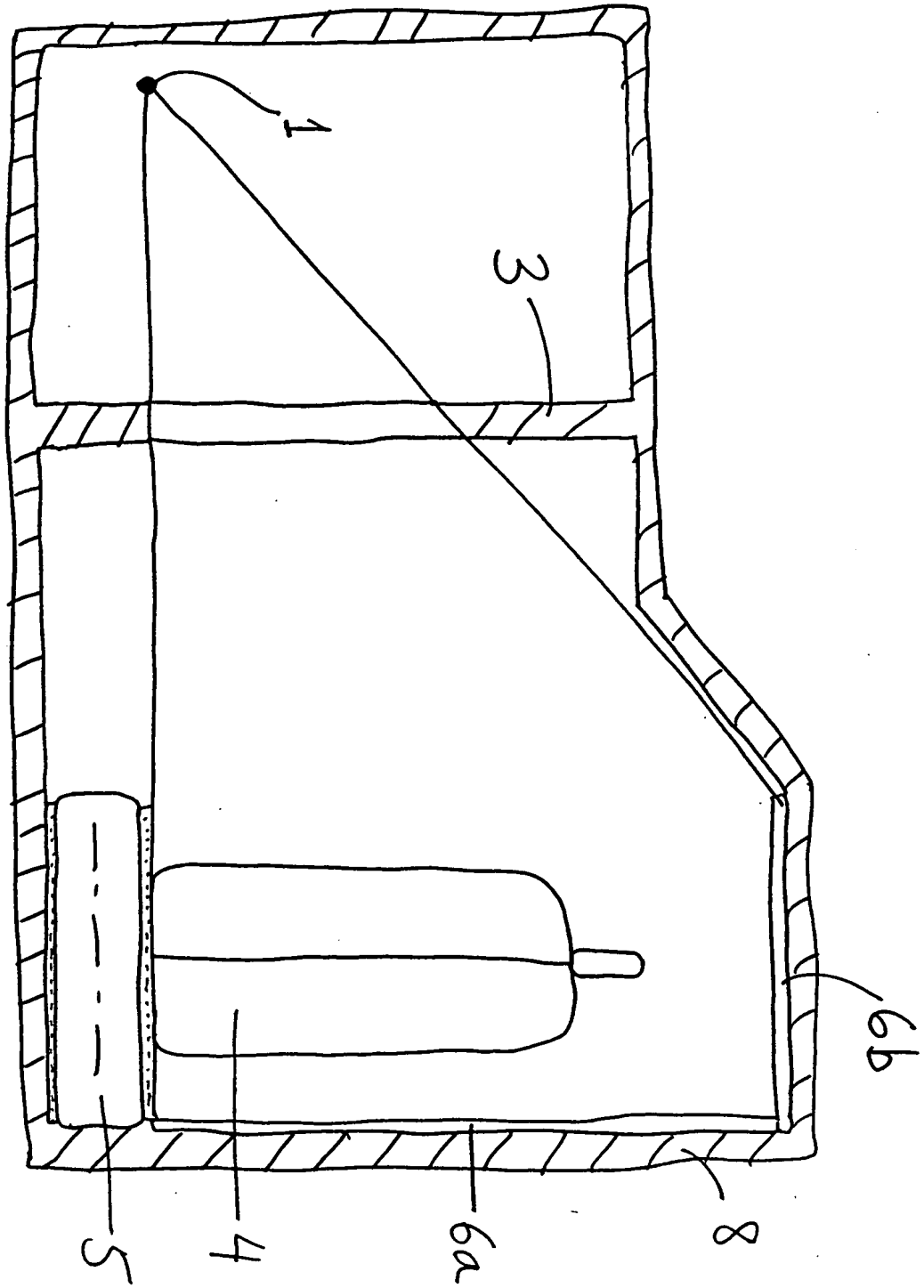


FIGURE 2

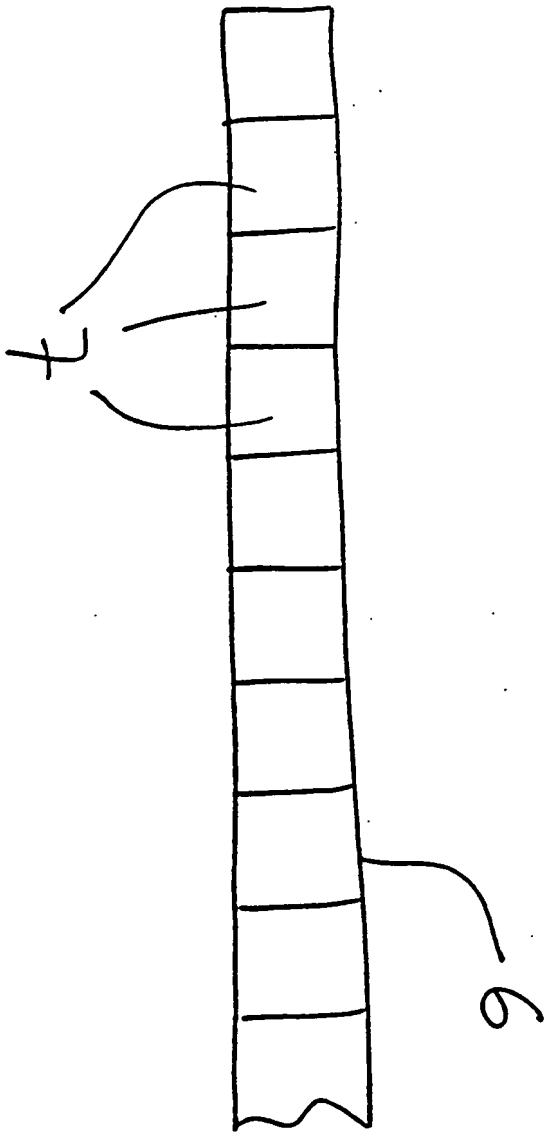


FIGURE 3

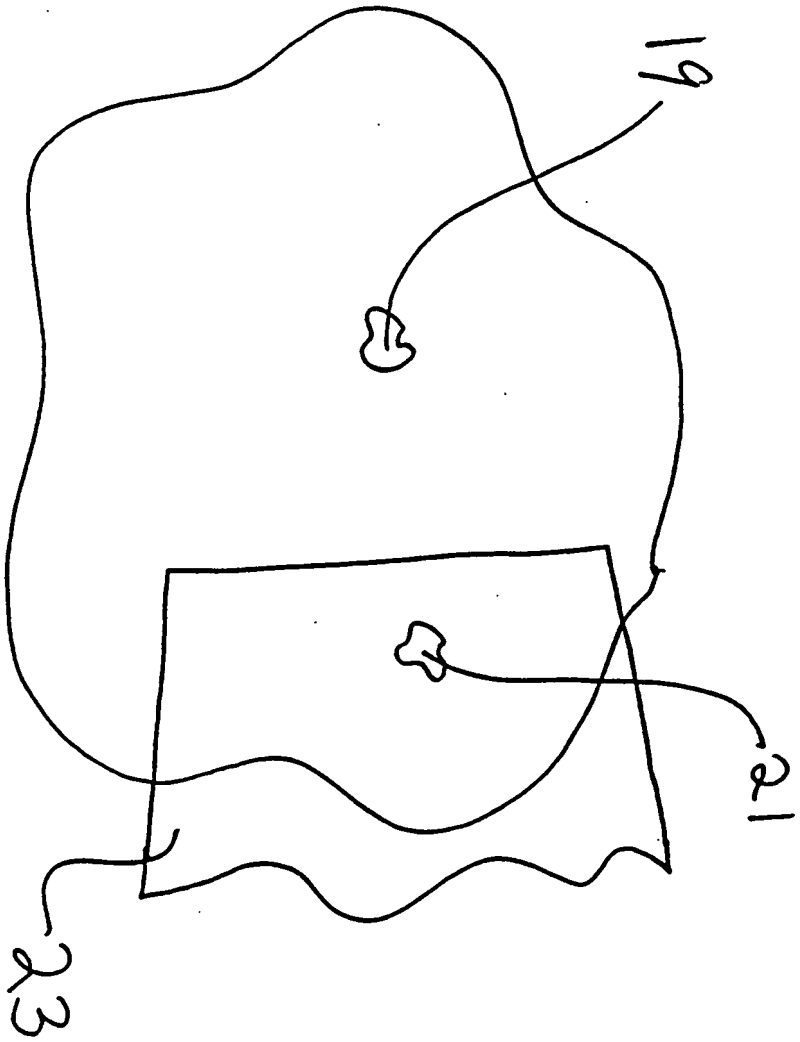


FIGURE 4

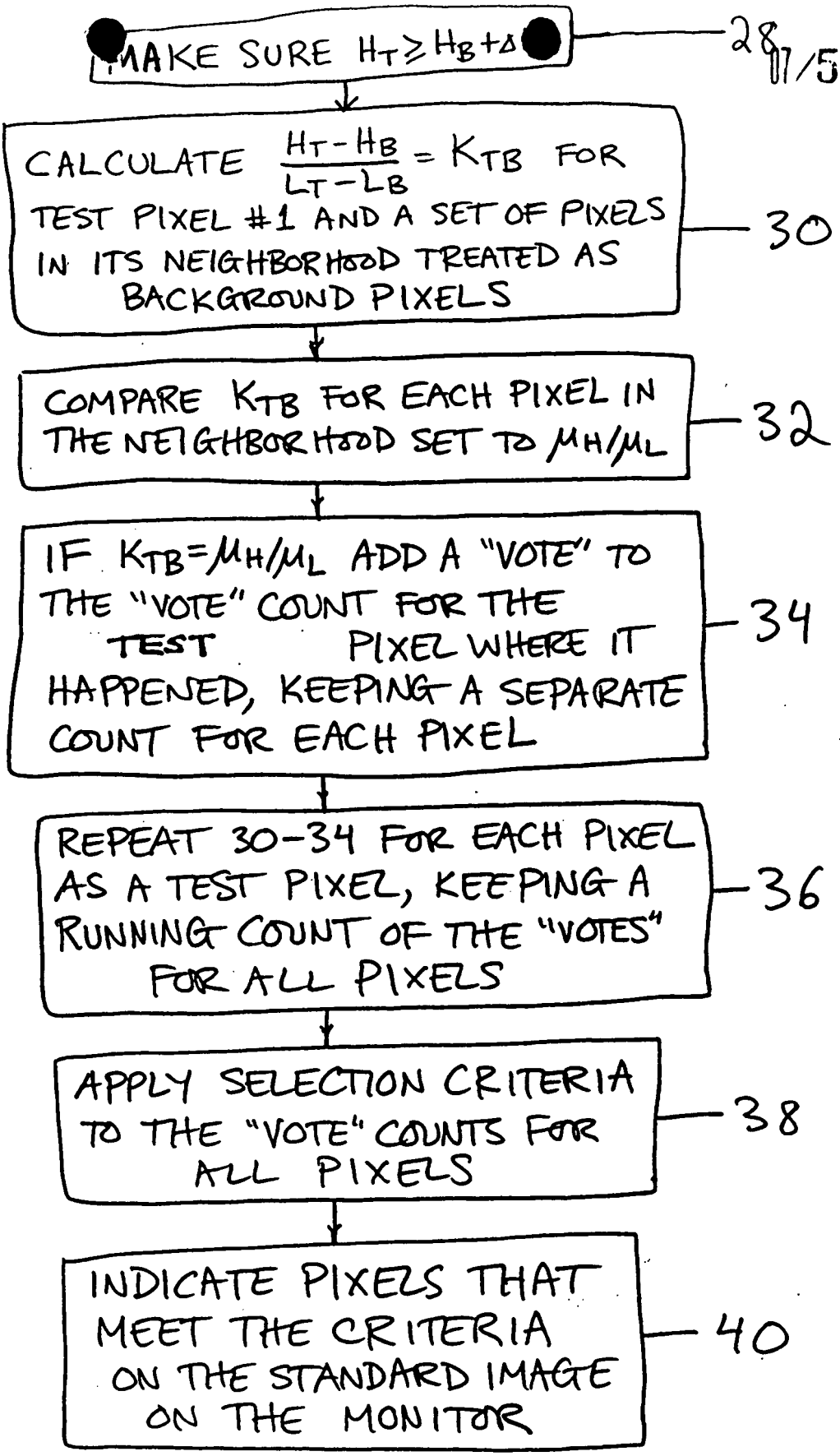

MAKE SURE $H_T \geq H_B + \Delta$
28
CALCULATE $\frac{H_T - H_B}{L_T - L_B} = K_{TB}$ FOR TEST PIXEL #1 AND A SET OF PIXELS IN ITS NEIGHBORHOOD TREATED AS BACKGROUND PIXELS
30
COMPARE K_{TB} FOR EACH PIXEL IN THE NEIGHBORHOOD SET TO μ_H/μ_L
32
IF $K_{TB} = \mu_H/\mu_L$ ADD A "VOTE" TO THE "VOTE" COUNT FOR THE TEST PIXEL WHERE IT HAPPENED, KEEPING A SEPARATE COUNT FOR EACH PIXEL
34
REPEAT 30-34 FOR EACH PIXEL AS A TEST PIXEL, KEEPING A RUNNING COUNT OF THE "VOTES" FOR ALL PIXELS
36
APPLY SELECTION CRITERIA TO THE "VOTE" COUNTS FOR ALL PIXELS
38
INDICATE PIXELS THAT MEET THE CRITERIA ON THE STANDARD IMAGE ON THE MONITOR
40

FIGURE 5

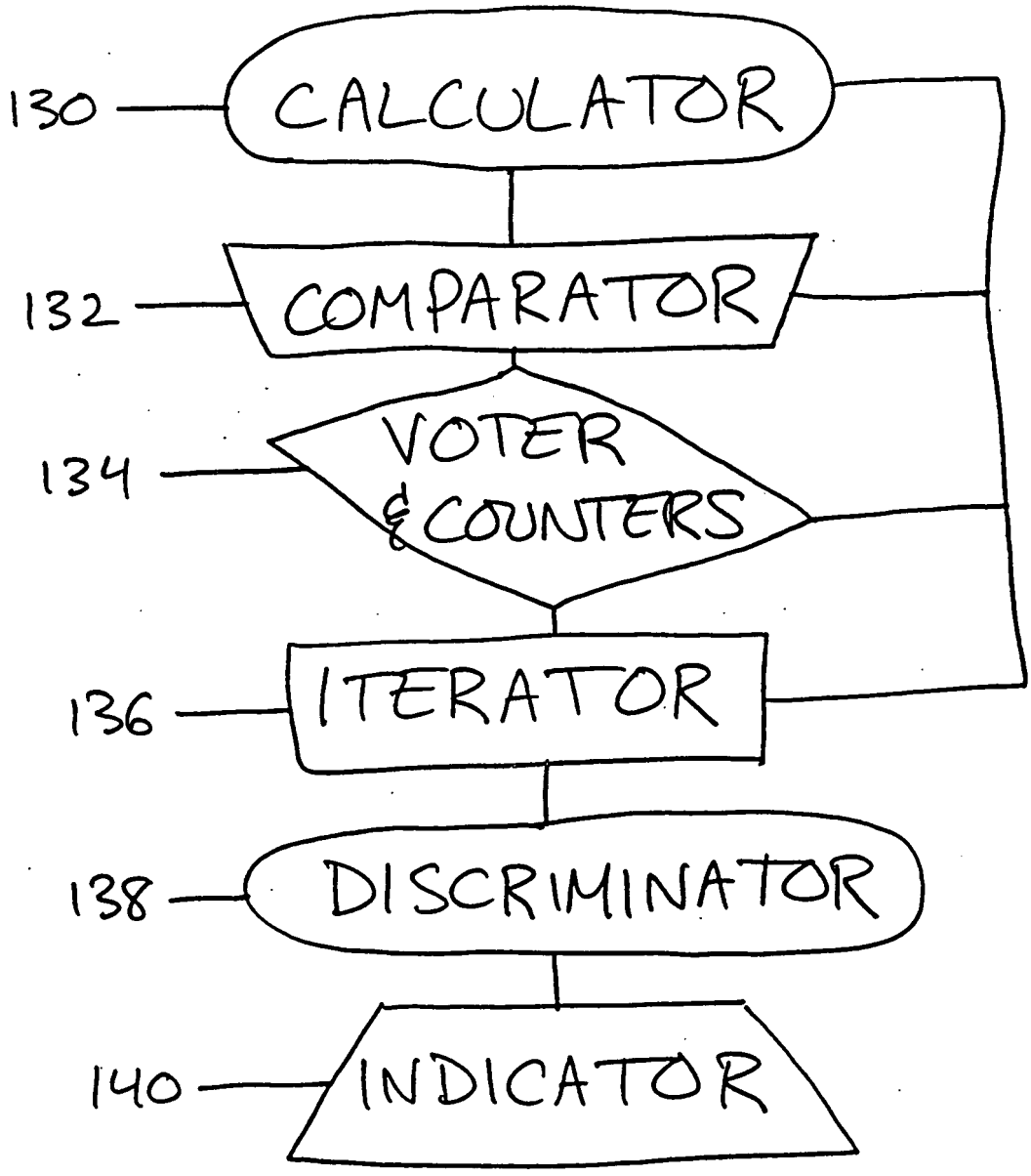

130
CALCULATOR
132
COMPARATOR
134
VOTER & COUNTERS
136
ITERATOR
138
DISCRIMINATOR
140
INDICATOR

FIGURE 6

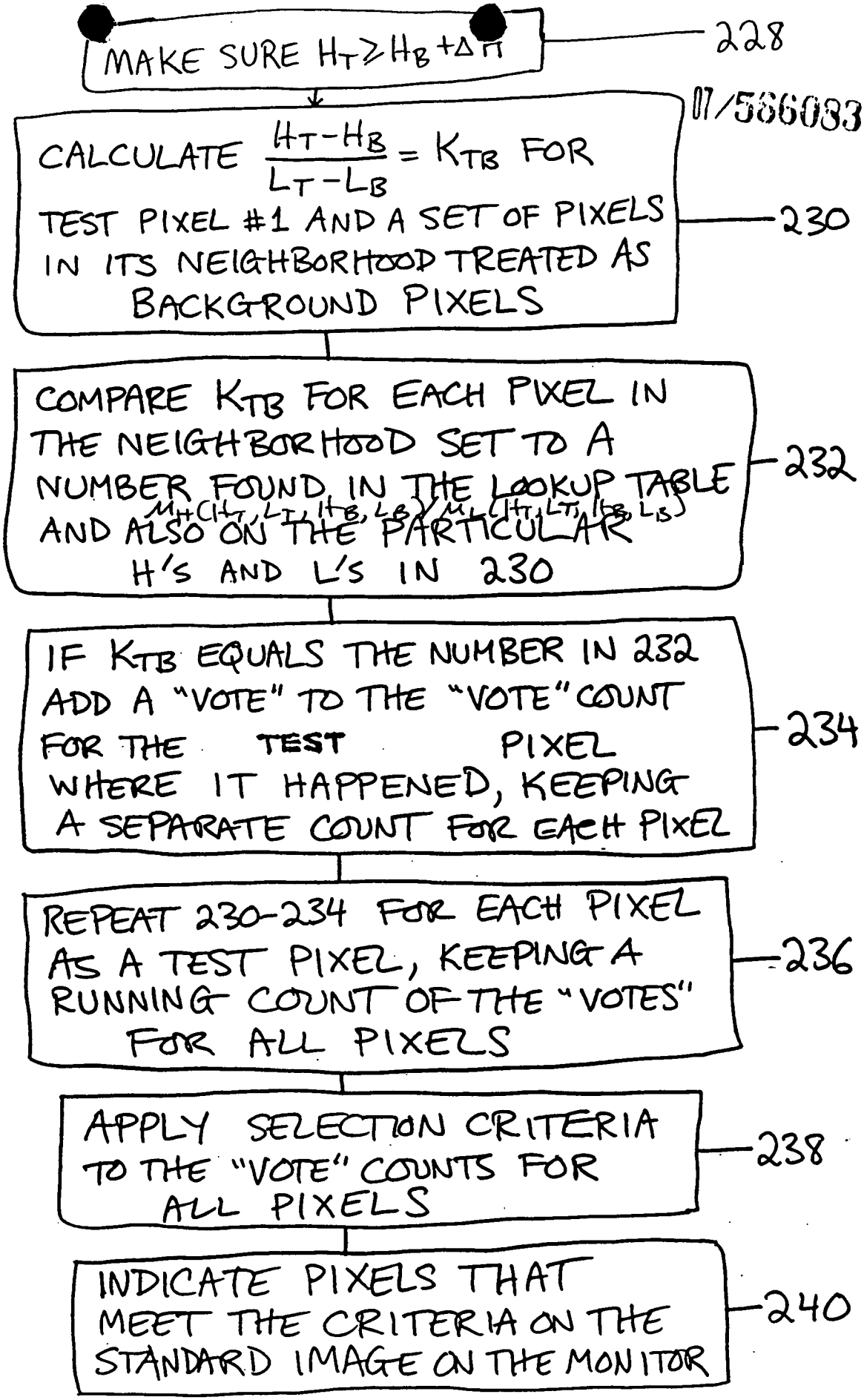

MAKE SURE $H_T \geq H_B + \Delta H$
228
CALCULATE $\frac{H_T - H_B}{L_T - L_B} = K_{TB}$ FOR TEST PIXEL #1 AND A SET OF PIXELS IN ITS NEIGHBORHOOD TREATED AS BACKGROUND PIXELS
230
COMPARE K_{TB} FOR EACH PIXEL IN THE NEIGHBORHOOD SET TO A NUMBER FOUND IN THE LOOKUP TABLE AND ALSO ON THE PARTICULAR H's AND L's IN 230
232
IF K_{TB} EQUALS THE NUMBER IN 232 ADD A "VOTE" TO THE "VOTE" COUNT FOR THE TEST PIXEL WHERE IT HAPPENED, KEEPING A SEPARATE COUNT FOR EACH PIXEL
234
REPEAT 230-234 FOR EACH PIXEL AS A TEST PIXEL, KEEPING A RUNNING COUNT OF THE "VOTES" FOR ALL PIXELS
236
APPLY SELECTION CRITERIA TO THE "VOTE" COUNTS FOR ALL PIXELS
238
INDICATE PIXELS THAT MEET THE CRITERIA ON THE STANDARD IMAGE ON THE MONITOR
240

FIGURE 7

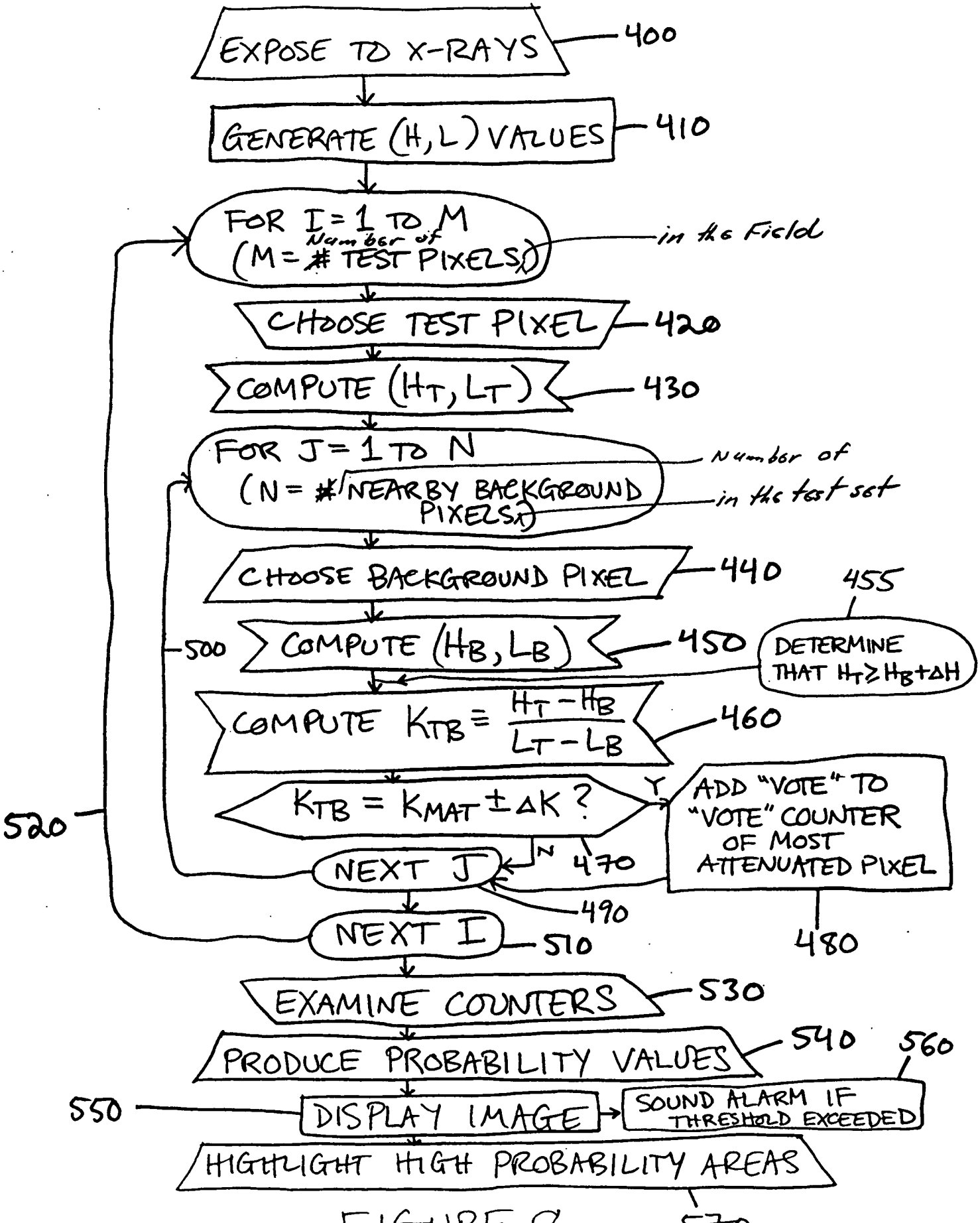

EXPOSE TO X-RAYS
400
GENERATE (H,L) VALUES
410
FOR I = 1 TO M
(M = # TEST PIXELS)
Number of in the Field
CHOOSE TEST PIXEL
420
COMPUTE (HT, LT)
430
FOR J = 1 TO N
(N = # NEARBY BACKGROUND PIXELS)
Number of in the test set
CHOOSE BACKGROUND PIXEL
440
455
500
COMPUTE (HB, LB)
450
DETERMINE THAT HT ≥ HB + ΔH
COMPUTE KTB ≡ (HT − HB) / (LT − LB)
460
KTB = KMAT ± ΔK ?
Y
ADD "VOTE" TO "VOTE" COUNTER OF MOST ATTENUATED PIXEL
520
N
NEXT J
470
490
480
NEXT I
510
EXAMINE COUNTERS
530
PRODUCE PROBABILITY VALUES
540
560
550
DISPLAY IMAGE
SOUND ALARM IF THRESHOLD EXCEEDED
HIGHLIGHT HIGH PROBABILITY AREAS
570

FIGURE 8

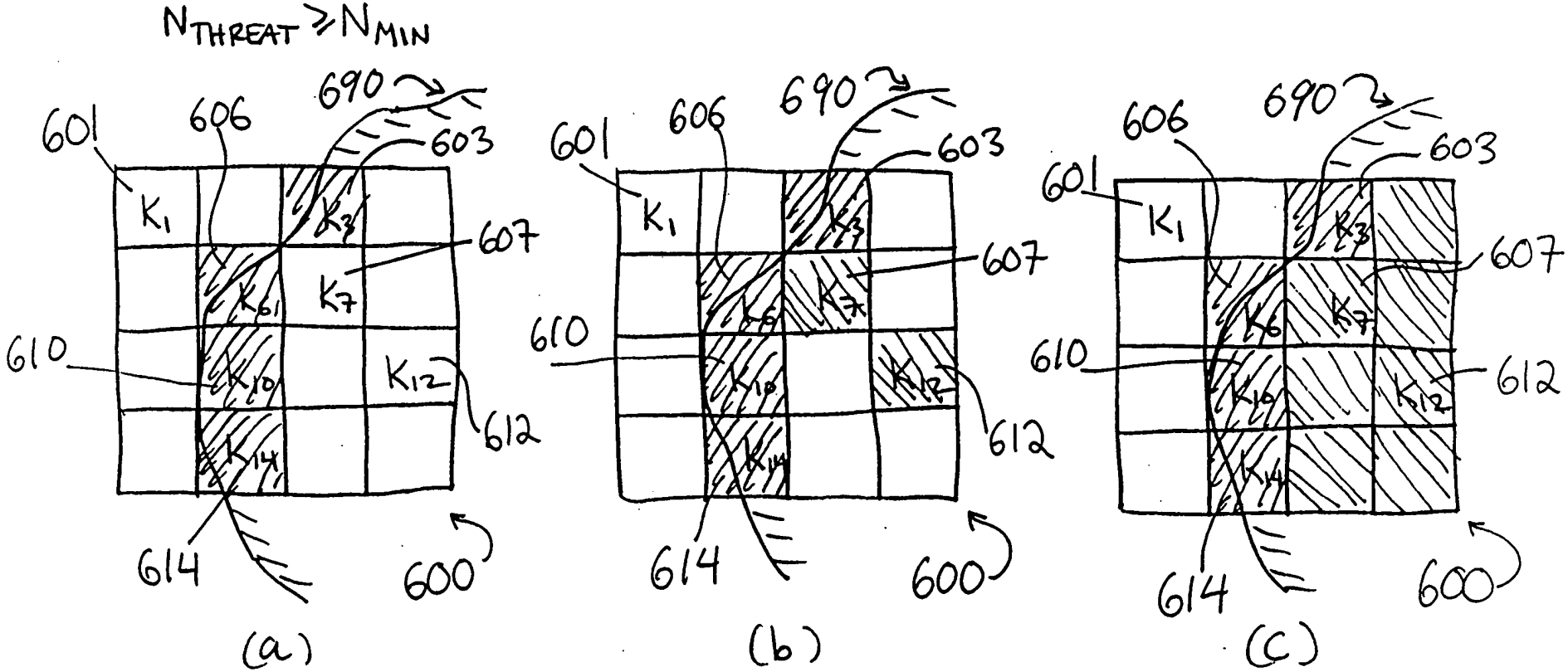

$N_{THREAT} \geq N_{MIN}$
601
606
690
603
607
610
612
614
600
K_1
K_3
K_{61}
K_7
K_{10}
K_{12}
K_{14}
(a)
(b)
(c)
$|K_1 - K_{AV}| > \Delta K$
$|K_7 - K_{AV}| \leq \Delta K$
$|K_{12} - K_{AV}| \leq \Delta K$

FIGURE 9

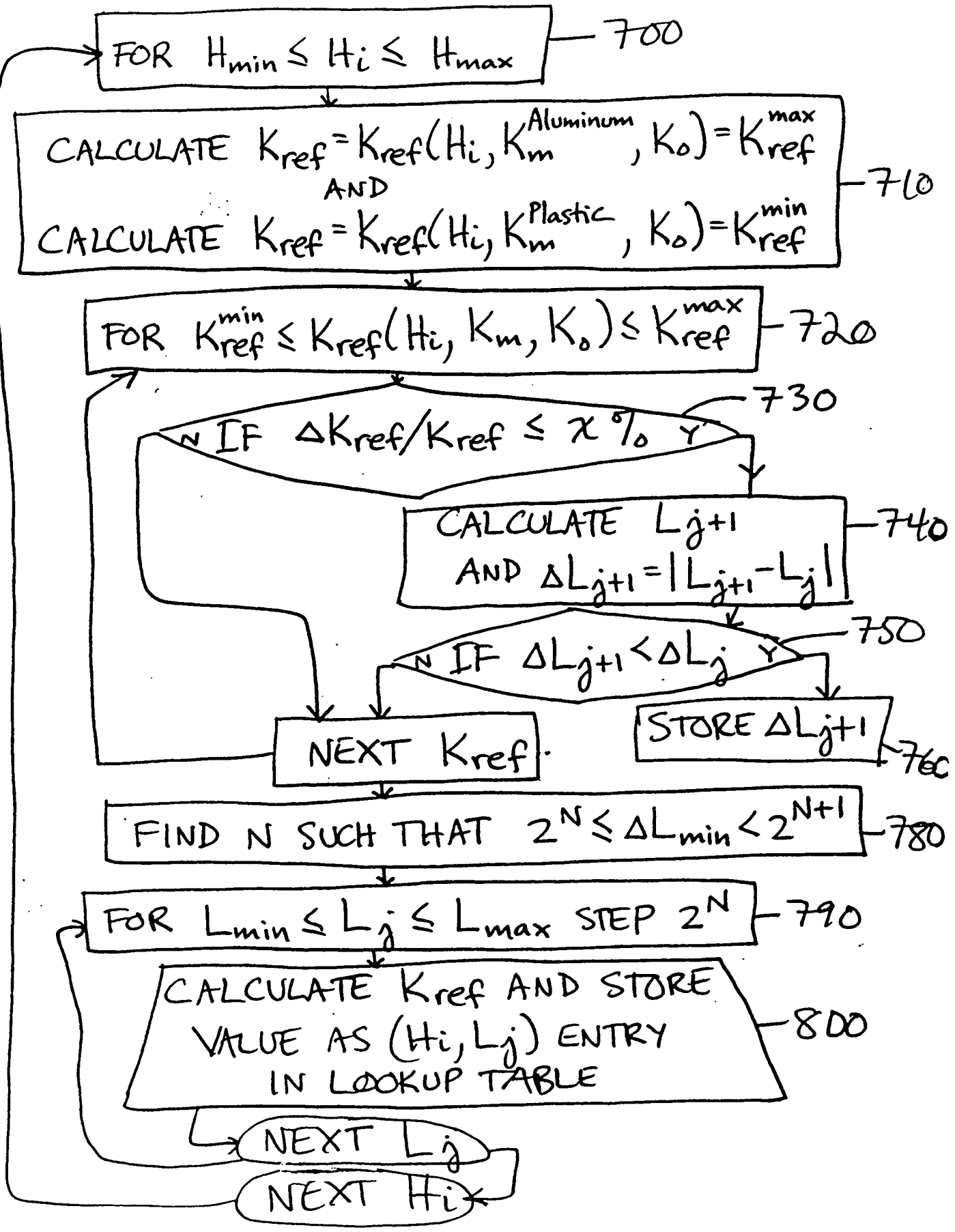

FOR $H_{min} \leq H_i \leq H_{max}$
700
CALCULATE $K_{ref} = K_{ref}(H_i, K_m^{Aluminum}, K_o) = K_{ref}^{max}$
AND
CALCULATE $K_{ref} = K_{ref}(H_i, K_m^{Plastic}, K_o) = K_{ref}^{min}$
710
FOR $K_{ref}^{min} \leq K_{ref}(H_i, K_m, K_o) \leq K_{ref}^{max}$
720
730
N IF $\Delta K_{ref}/K_{ref} \leq X\%$ Y
CALCULATE L_{j+1} AND $\Delta L_{j+1} = |L_{j+1} - L_j|$
740
750
N IF $\Delta L_{j+1} < \Delta L_j$ Y
NEXT Kref
STORE ΔL_{j+1}
760
FIND N SUCH THAT $2^N \leq \Delta L_{min} < 2^{N+1}$
780
FOR $L_{min} \leq L_j \leq L_{max}$ STEP 2^N
790
CALCULATE K_{ref} AND STORE VALUE AS (H_i, L_j) ENTRY IN LOOKUP TABLE
800
NEXT L_j
NEXT H_i

FIGURE 10

Fig 11

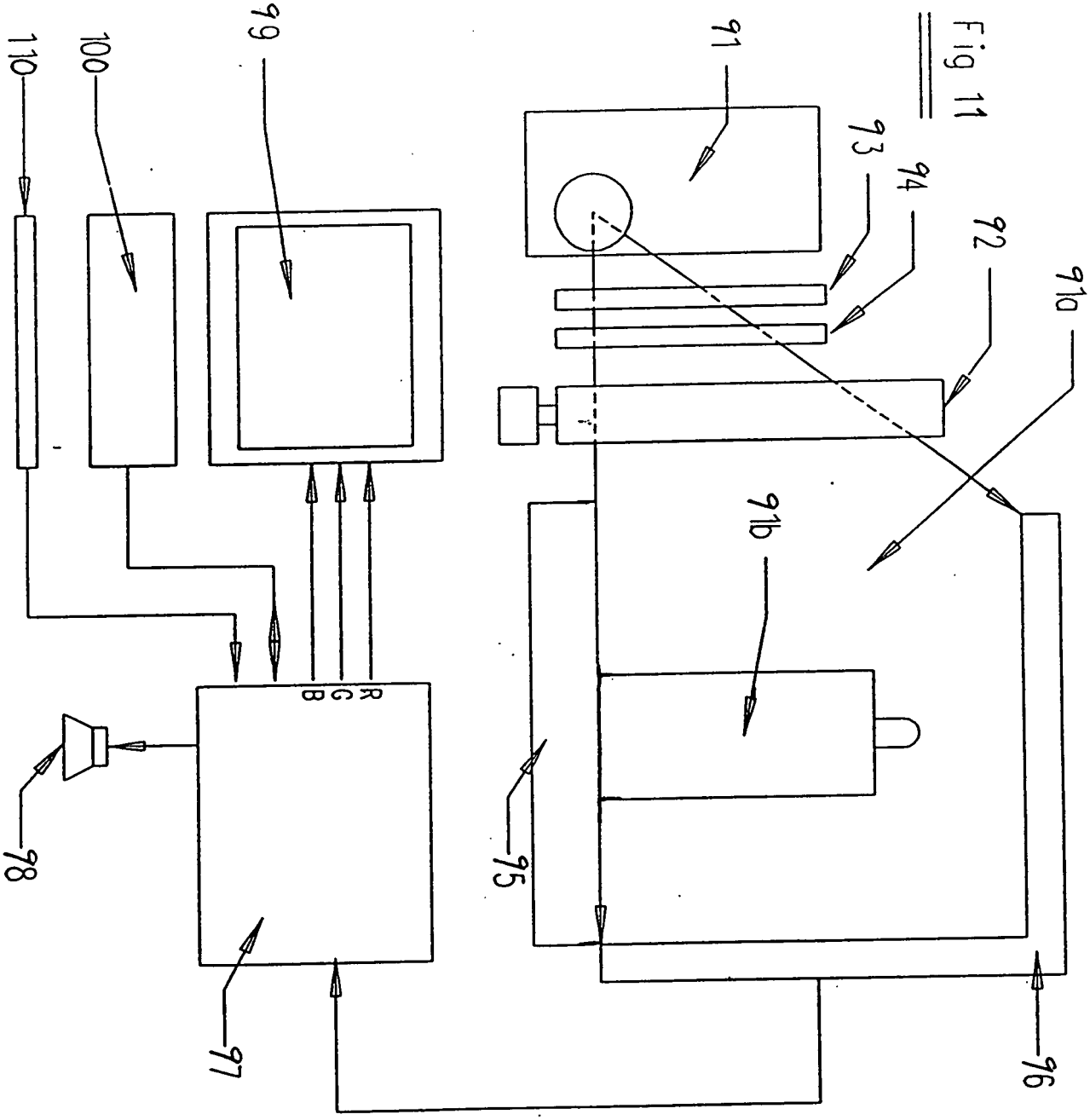
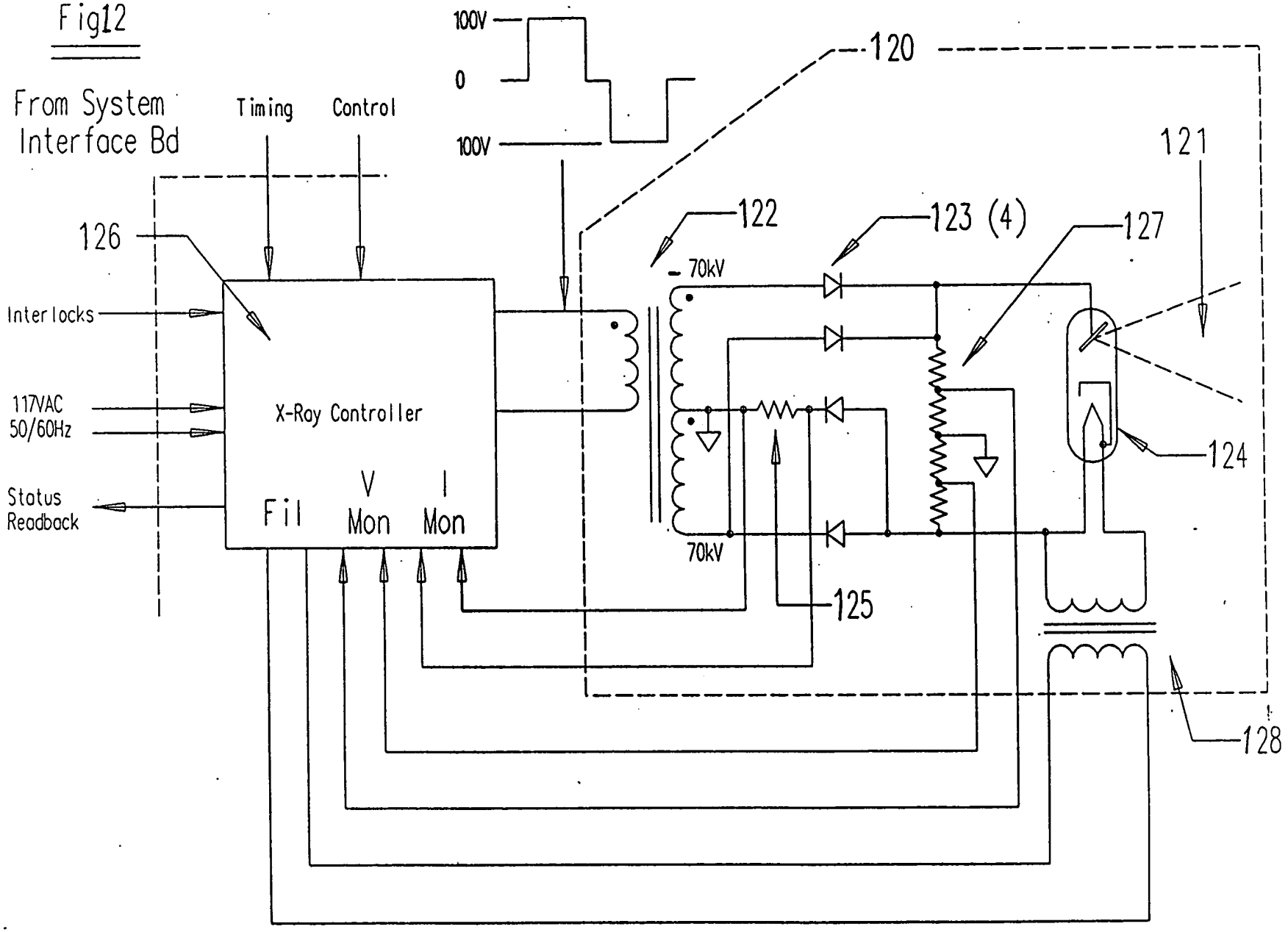
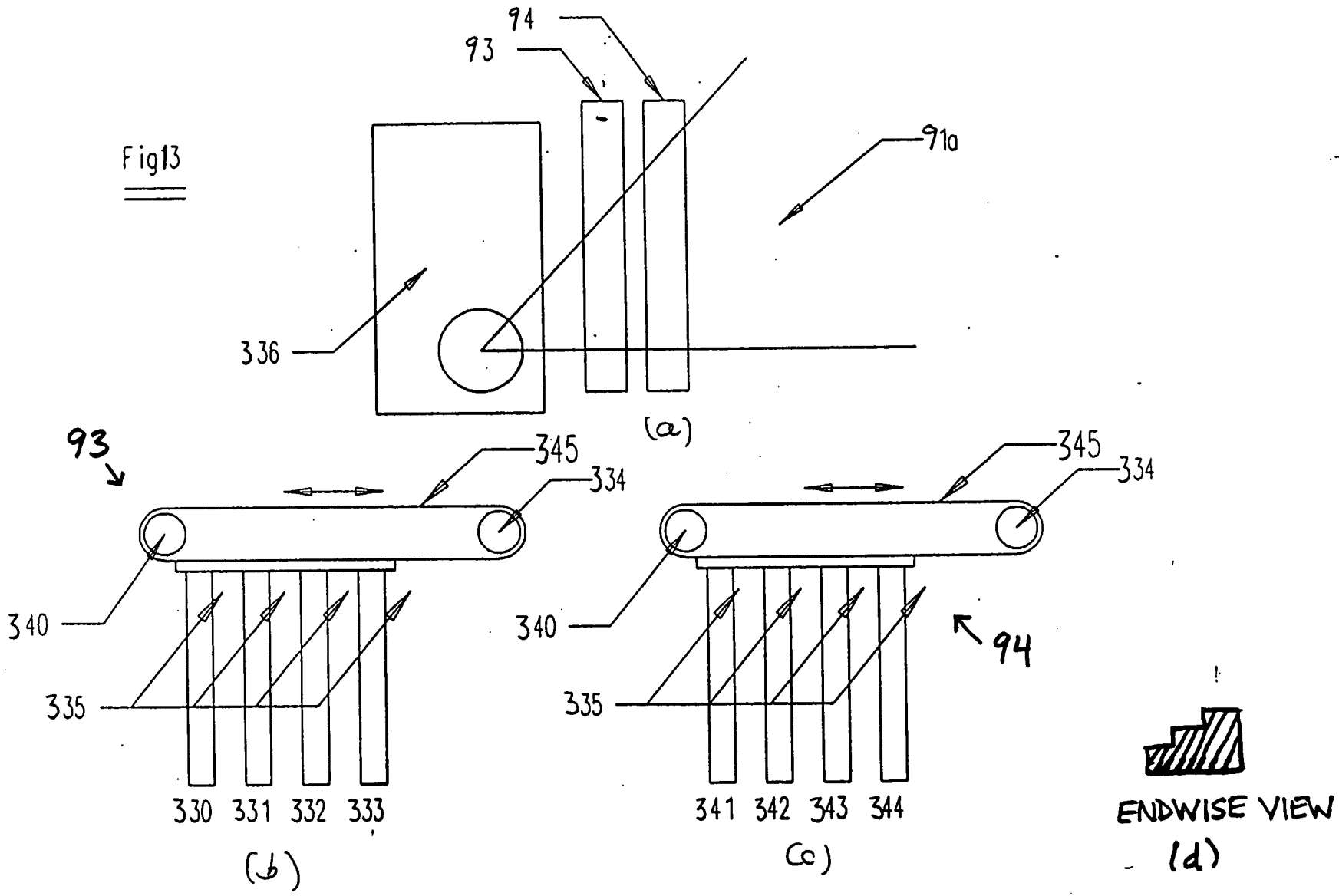


Fig12


From System Interface Bd
Timing
Control
100V
0
100V
120
121
126
122
123 (4)
127
Interlocks
117VAC 50/60Hz
Status Readback
X-Ray Controller
Fil
V Mon
I Mon
70kV
70kV
124
125
128

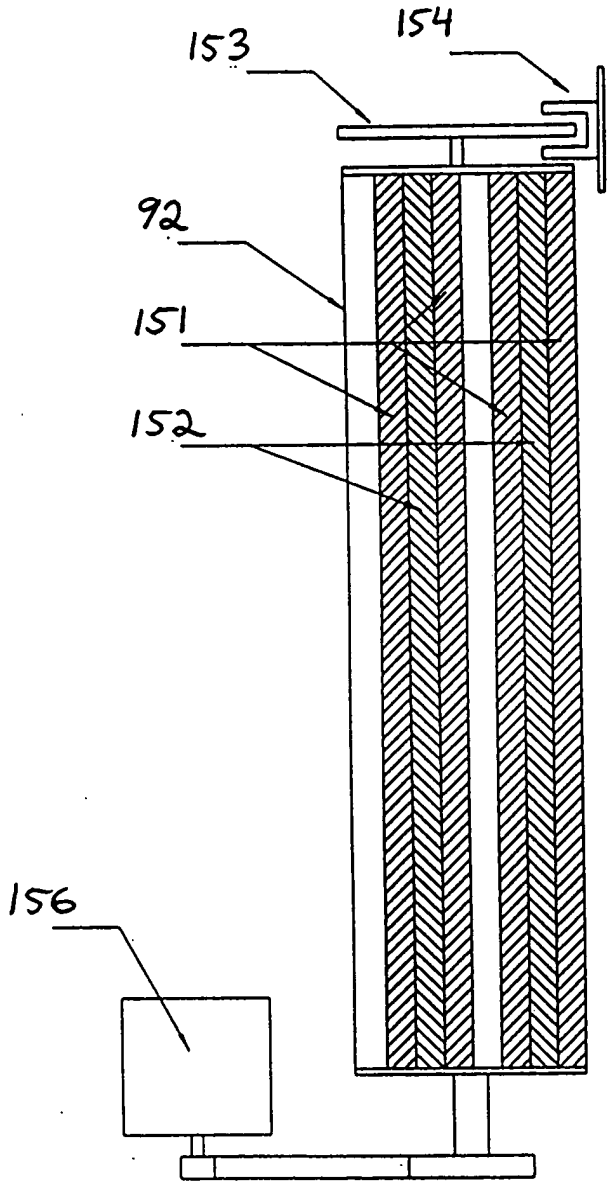
07/566083

Fig13

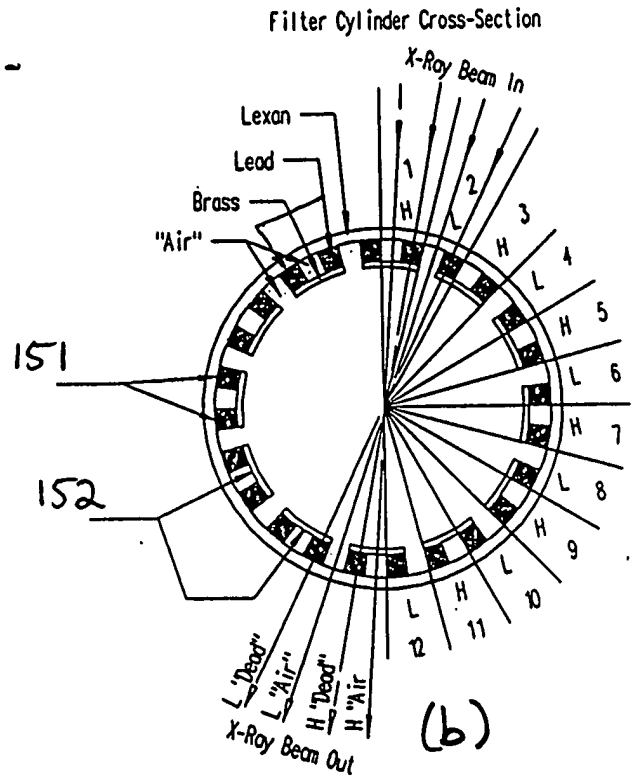


07/566083

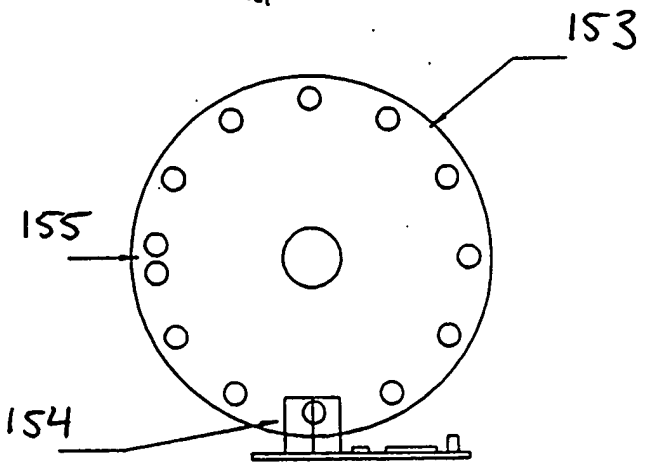
FIG. 14



(a)



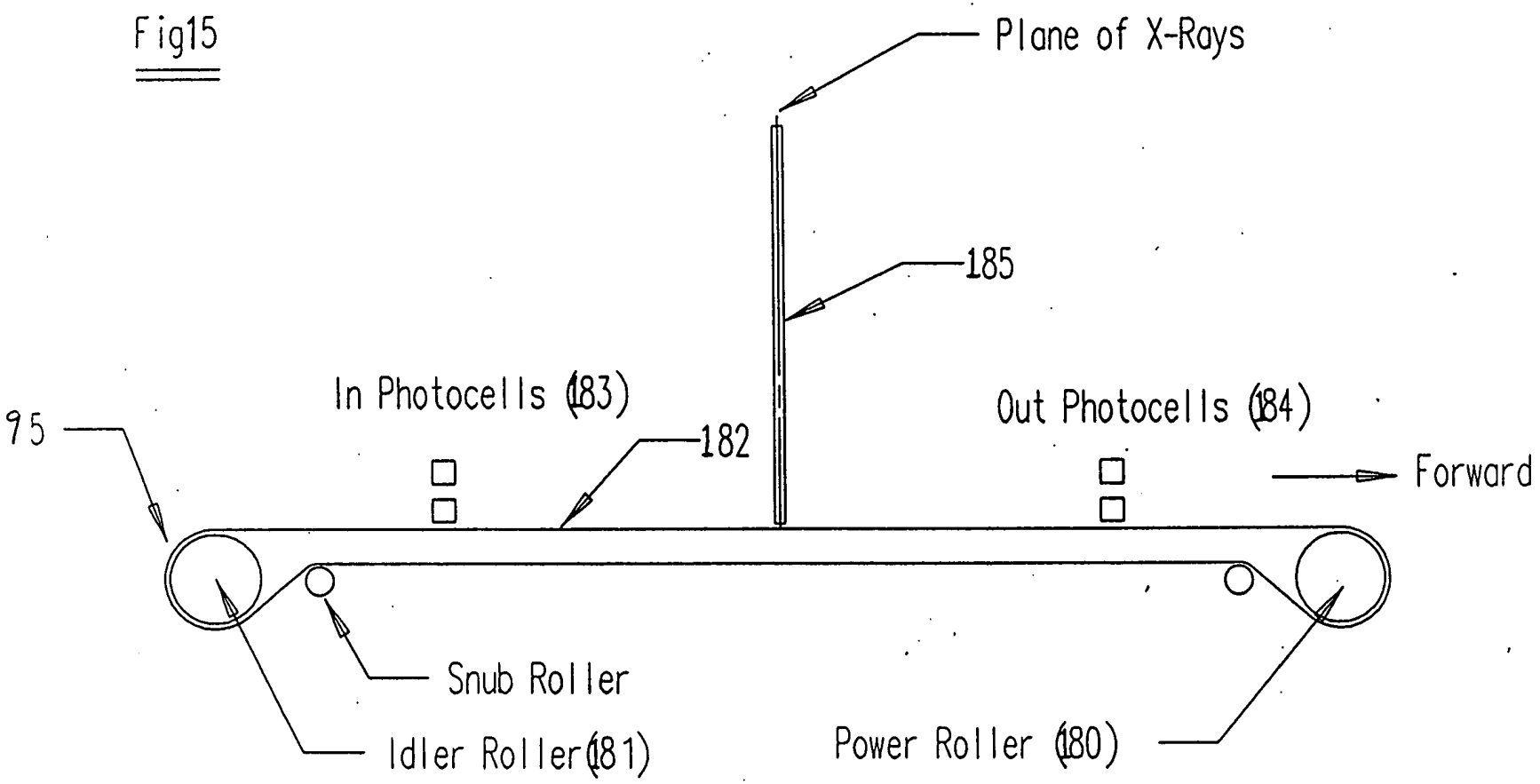
(b)



(c)

07/566083

Fig15



07/566083

FIG16

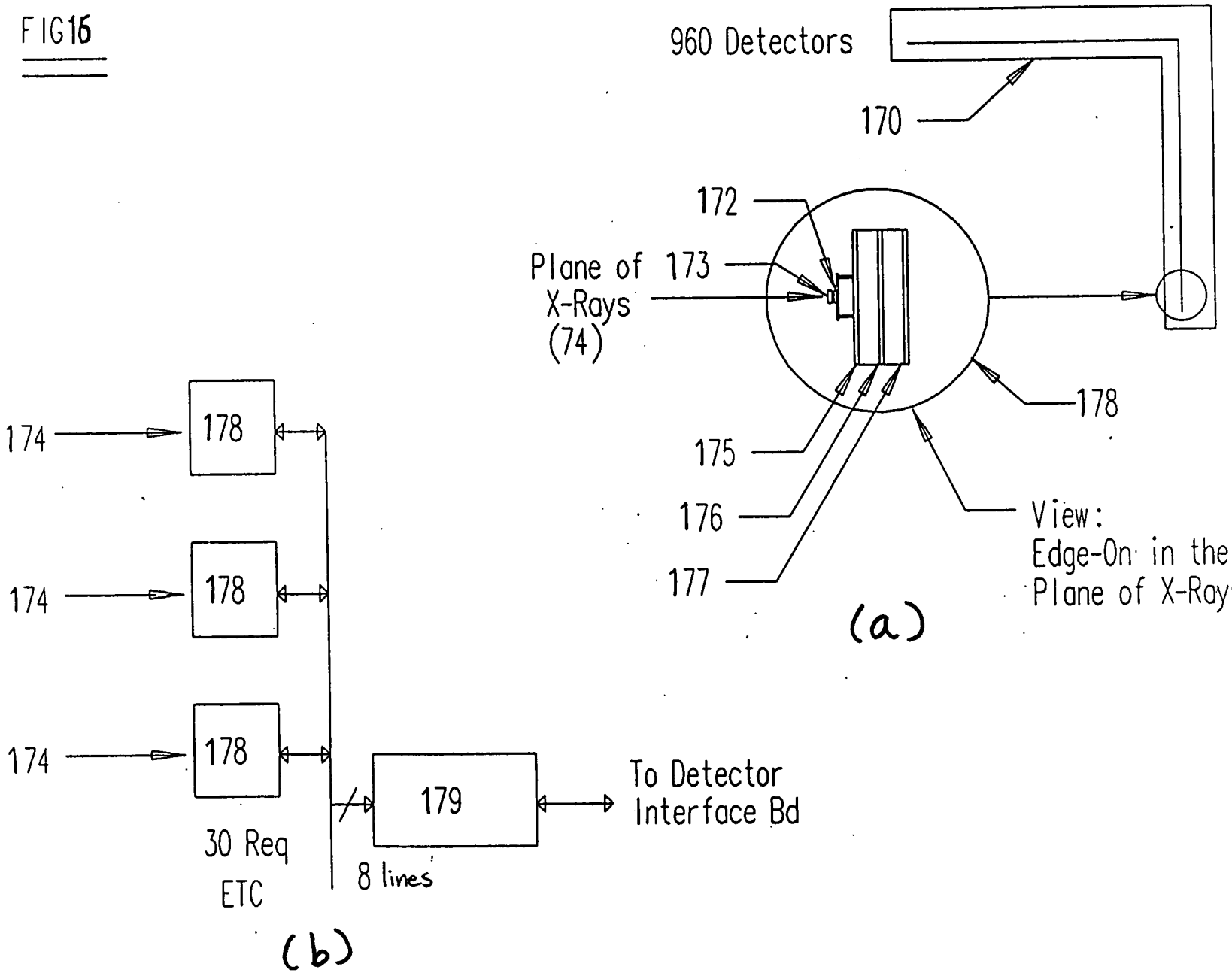
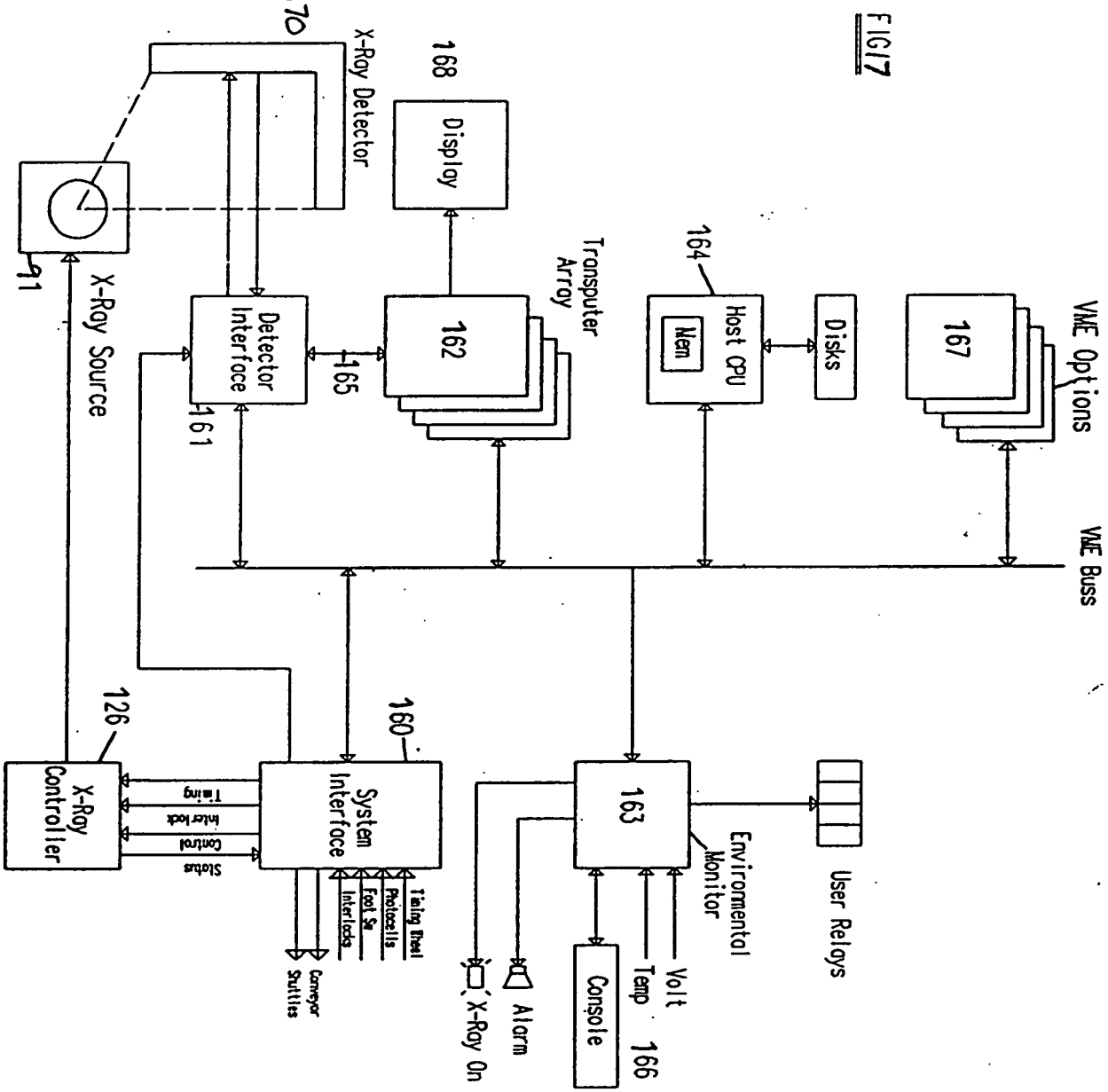


FIG17


VME Options
VME Buss
167
Host CPU
Mem
164
Disks
Transputer Array
162
Display
168
X-Ray Detector
170
Detector Interface
161
165
X-Ray Source
91
126
X-Ray Controller
System Interface
160
163
Environmental Monitor
User Relays
Console
166
Volt
Temp
Alarm
X-Ray On
Status
Control
Interlock
Timing
Tiling Wheel
Photocells
Foot Sw
Interlocks
Conveyor Shuttles

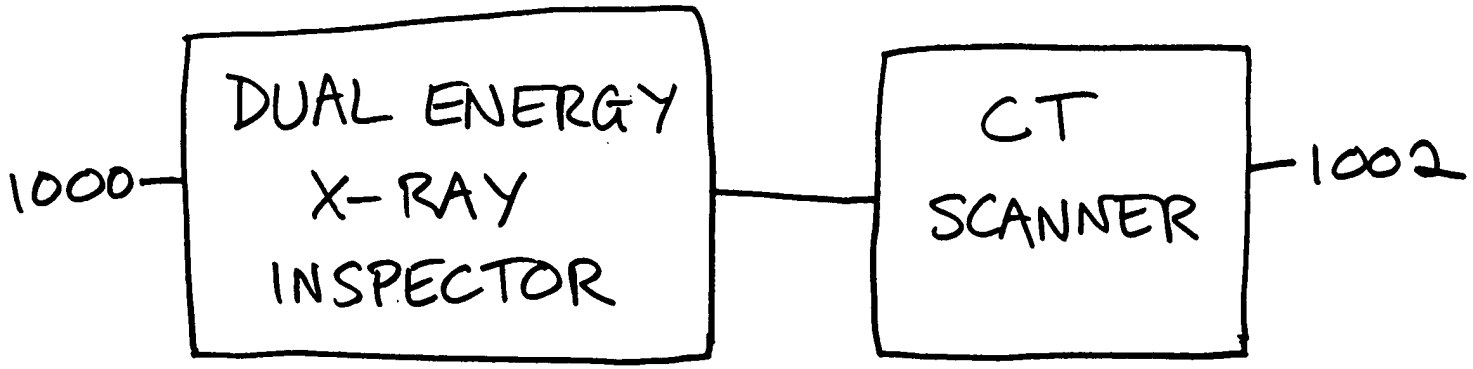


FIGURE 18a

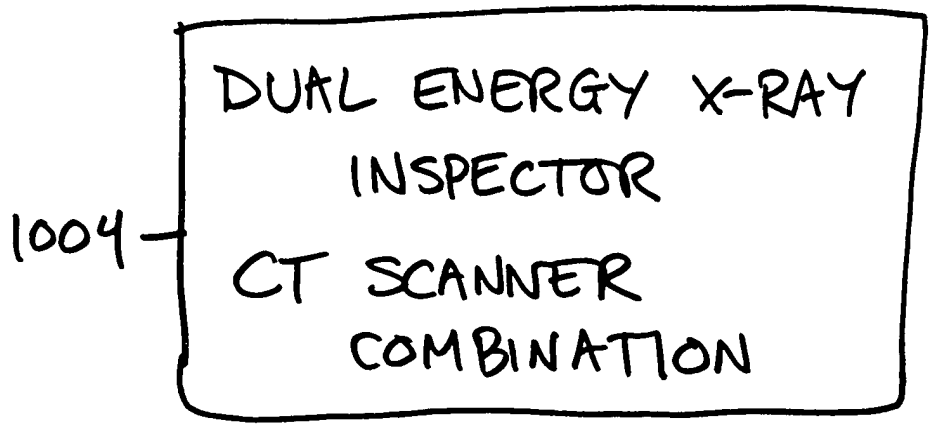


FIGURE 18b

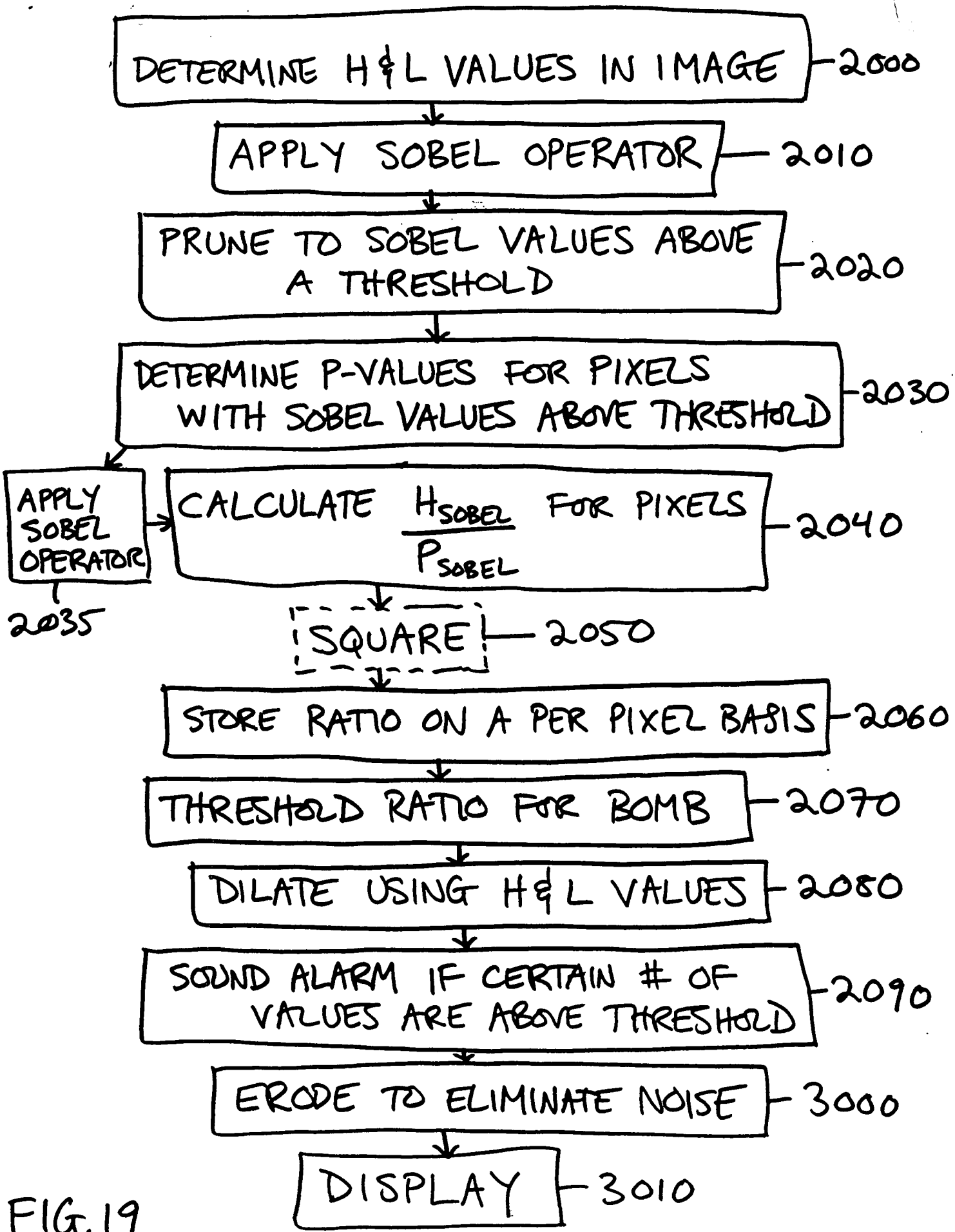

DETERMINE H & L VALUES IN IMAGE
2000
APPLY SOBEL OPERATOR
2010
PRUNE TO SOBEL VALUES ABOVE A THRESHOLD
2020
DETERMINE P-VALUES FOR PIXELS WITH SOBEL VALUES ABOVE THRESHOLD
2030
APPLY SOBEL OPERATOR
2035
CALCULATE $\frac{H_{SOBEL}}{P_{SOBEL}}$ FOR PIXELS
2040
SQUARE
2050
STORE RATIO ON A PER PIXEL BASIS
2060
THRESHOLD RATIO FOR BOMB
2070
DILATE USING H & L VALUES
2080
SOUND ALARM IF CERTAIN # OF VALUES ARE ABOVE THRESHOLD
2090
ERODE TO ELIMINATE NOISE
3000
DISPLAY
3010

FIG. 19

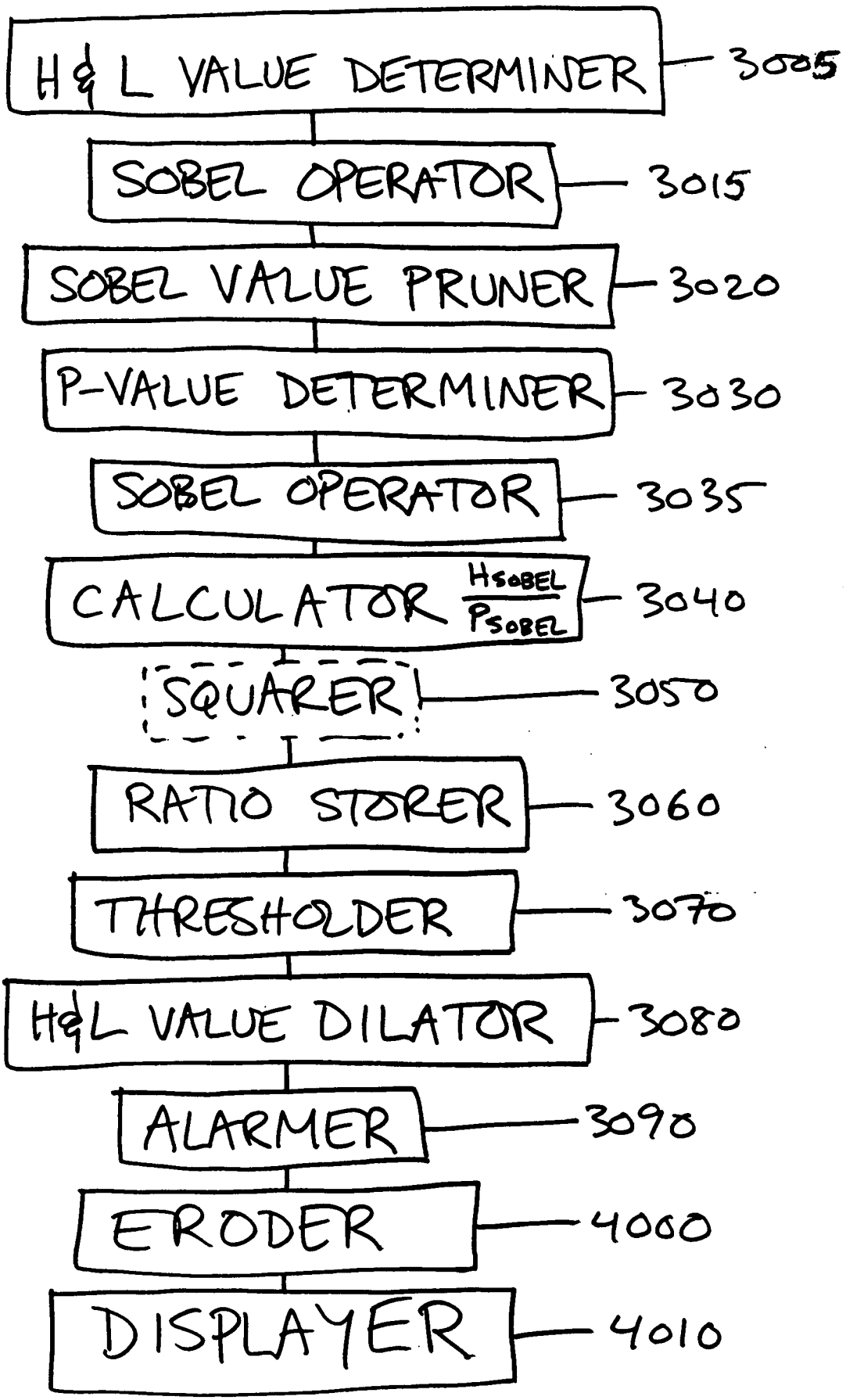

H & L VALUE DETERMINER
3005
SOBEL OPERATOR
3015
SOBEL VALUE PRUNER
3020
P-VALUE DETERMINER
3030
SOBEL OPERATOR
3035
CALCULATOR $\frac{H_{SOBEL}}{P_{SOBEL}}$
3040
SQUARER
3050
RATIO STORER
3060
THRESHOLDER
3070
H&L VALUE DILATOR
3080
ALARMER
3090
ERODER
4000
DISPLAYER
4010

FIGURE 20